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FILING DATE: *February 14, 2001*
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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Johannes W.G.M.	Huijbers	Eden Prairie, Minnesota
Dennis L.	Mills	Long Lake, Minnesota

☐ *Additional inventors are being named on the ___ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

Hydraulically actuated toolholder

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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ENCLOSED APPLICATION PARTS *(check all that apply)*

[X] Specification *Number of Pages* 9 ☐ CD(s), Number

[X] Drawing(s) *Number of Sheets* 7 ☐ Other (specify)

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

[X] Applicant claims small entity status. See 37 CFR 1.27.

[X] A check or money order is enclosed to cover the filing fees

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FILING FEE AMOUNT ($): $75.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

[X] No

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ____________

Respectfully submitted,

SIGNATURE ____________ Date 02/ 09/ 01

TYPED or PRINTED NAME Johannes W.G.M. Huijbers

REGISTRATION NO. (if appropriate)

Docket Number:

TELEPHONE 952-404-1890

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

January 11, 2001

SPECIFICATION

TO WHOM IT MAY CONCERN:

BE IT KNOWN, That we, Dennis Mills, a resident of Long Lake, Hennepin County, Minnesota and a citizen of the United States and Johannes W.G.M. Huijbers, a resident of Plymouth, Hennepin County and a citizen of The Netherlands have invented certain new and useful improvements in a:

HYDRAULICALLY ACTUATED TOOLHOLDER,

of which the following is a specification.

TITLE: "Hydraulically actuated toolholder"

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an improved hydraulically actuated toolholder for milling machines, and more particularly to a hydraulically actuated toolholder with an inserted hydraulic cartridge.

2. Description of Prior Art

Toolholders are used to provide the flexibility of using a variety of cutting tools in milling machines. There are currently toolholders on the market that for example are suited to hold end mills, drills, boring bars, taps and reamers. One side of the toolholder has a tapered shank according to one of the accepted taper standards for milling machines, such as for example a BT-taper, a CAT-taper or an HSK-taper. This tapered shank fits tightly into tapered recess in the rotating spindle of the milling machine. The other side of the toolholder, the nose piece, has a clamping mechanism for holding the cutting tool.

There is a variety of clamping mechanism designs for toolholders on the market. One of the most widespread toolholder designs are the set-screw type, where the cutting tool shank is held in the toolholder bore by one or more set-screws, and the collet-type, where the cutting tool shank is held by a collapsible collet, pressed onto the cutting tool shank. These designs are relatively inexpensive, but do not offer a very high total indicated run-out accuracy, which is the maximum possible distance the cutting tool center location

is off the tapered shank centerline of the toolholder. A hydraulically actuated toolholder, although more expensive than the set-screw or the collet-type toolholder has a relatively much higher total indicated run-out accuracy. This is the reason that this type of toolholder is used in more demanding, high-speed cutting operations.

The hydraulically actuated toolholder holds the shank of the cutting tool by "collapsing" a thin shell hydraulically around the cutting tool shank. The toolholder has an internal hydraulic circuit, which allows for hydraulic fluid around this thin shell. The inside of the shell forms the bore of the toolholder. The hydraulic circuit furthermore has a piston bore, a bleed hole and the necessary hydraulic passages to connect the part of the hydraulic circuit around the thin shell to the piston bore and the bleed hole. The necessary hydraulic pressure to collapse the thin shell and provide enough holding torque for the cutting tool, 15,000 psi, is generated by displacing a sealed piston in the piston bore, usually by means of a capscrew or other type of screw.

The current designs of hydraulically actuated toolholders on the market all are integrated designs. The toolholder has an integral hydraulic circuit. One particular type of design has the main part of the hydraulic circuit machined in the toolholder and a thin shell inserted and brazed into a bore in the toolholder, completing the hydraulic circuit. Another type has the thin shell machined as part of the toolholder as well as the main part of the hydraulic circuit and a nose cone welded around the thin shell to complete the hydraulic circuit. Both designs have hydraulic circuits with relatively intricate geometry and are expensive and difficult to manufacture due to the integral design.

The intricate geometry of the hydraulic circuit has more disadvantages. The intricacy of the hydraulic circuit geometry makes it difficult to clean. The resultant

contamination of the hydraulic circuit can cause excessive wear of the piston seal, resulting in reduced seal life and possibly in leakage, causing the toolholder to generate insufficient holding torque. Furthermore the intricate geometry makes it difficult to fill the hydraulic circuit completely and consistently with hydraulic fluid, causing a relatively high percentage of air entrapped in the fluid. This causes a variation of hydraulic pressure and therefore holding torque between manufactured toolholders. Also the volume of the hydraulic circuit for the integral design is quite large, demanding a relatively high displacement of the piston or a large piston bore, both of which are disadvantages.

It is clear from the discussion of existing hydraulically actuated toolholder designs, that there is quite some room for improvement and a need for a better design, that eliminates the disadvantages inherent in the current designs.

SUMMARY OF THE INVENTION

In contrast to prior art in hydraulically actuated toolholders, the present invention relates to an improved hydraulically actuated toolholder with an inserted hydraulic cartridge. Instead of having a toolholder with an integral hydraulic circuit, this type of hydraulically actuated toolholder separates the two design functions of locating and holding the toolholder in the tapered recess of the milling machine's rotating spindle and of locating and holding the cutting tool in the clamping mechanism in the nose piece of the toolholder.

The toolholder consists of two main parts, the toolholder body and the hydraulic cartridge. The toolholder body performs the first design function. It has a tapered shank on one end that fits into the tapered recess of the rotating spindle. The other end has a

bore, made accurately on the centerline of the tapered shank. The second main part of the toolholder, the hydraulic cartridge, is during assembly pressed into this bore with an interference fit to locate in accurately. The separation of the two design functions allows for relatively inexpensive and simple manufacturing of the two parts, the body and the cartridge.

The hydraulic cartridge completely contains the hydraulic clamping mechanism and therefore the hydraulic circuit of the toolholder. The cartridge is made up out of a cartridge body with a thin inner shell, in which the entire hydraulic circuit is machined, and a thin cartridge shell. The cartridge body is pressed into the thin cartridge shell and they are subsequently brazed to provide a leak-tight hydraulic circuit.

The cartridge concept allows for a very simple hydraulic circuit design with a volume roughly one third of the current toolholder designs on the market with an integral hydraulic circuit concept. Furthermore the cartridge body and shell are very easily de-burred and cleaned before assembly and brazing, making the possibility of contamination in the hydraulic circuit a very small one. The part of the hydraulic circuit around the thin inner shell of the cartridge body is divided into two bands with a thicker part of the thin inner shell separating the two bands. This provides for two deformation bands of the thin inner shell during hydraulic actuation of the toolholder. Having two deformation bands results in a well defined clamping and alignment of the cutting tool shank in two locations of the shank. Having only one deformation band would result in an undefined clamping and alignment.

The hydraulic circuit is divided into three distinct volumes with passages connecting these volumes. The first two parts are the volumes formed by the space around

the two deformation bands, the lower clamping volume and the upper clamping volume. The lower clamping volume around the lower deformation band is connected by two u-shaped grooves through the thicker part of the thin inner shell. During the filling of the hydraulic circuit, one passage is used to fill the lower clamping volume with hydraulic fluid and the second passage is to evacuate the air in the lower clamping volume. The upper clamping volume is connected with the piston bore volume by a single, wider groove on one side of the cartridge body. This groove is inline with one of the grooves in the thicker part of the inner shell. The wider groove allows for both filling with hydraulic fluid and evacuating the air in the lower and upper clamping volume, and is easily accessible for inserting thin tubing for the filling procedure. The piston bore runs all the way through the cartridge body and is sealed on one side by the cartridge shell. The other side of the cartridge shell has a through-hole to allow for the installation of the piston seal and the piston. The design of the hydraulic circuit does not make a bleed hole a necessity for filling the circuit with hydraulic fluid without virtually any entrapped air, thereby eliminating the disadvantage of current toolholder designs.

The piston seal has a through-hole on centerline. This allows for easy installation as excess oil can escape through this through-hole. The piston has a pin, which fits tightly into the through-hole of the piston seal. During the installation of the piston, the through-hole in the piston seal is filled with hydraulic oil, which is displaced by the piston pin into the hydraulic circuit. The increase in volume of the hydraulic fluid in the circuit causes the piston seal and piston to back out slightly, but again no bleed hole is necessary and no air is introduced or trapped in the hydraulic circuit.

A slightly different application of the hydraulic cartridge is its use as a toolholder or lathe chuck with an expanding mandrel. The inner bore of the cartridge fits around the cylindrical end of a toolholder or chuck. In this application the flexible outer shell will fit inside a certain work piece or part. The actuation of the toolholder or chuck will expand the outer shell against the inner wall of the work piece bore and thus hold it in place. It is of course possible just to integrate the cartridge into the toolholder or chuck as the geometry for an expanding mandrel type holder is very suitable for such a design. The filling and installing of the piston seal and piston can be done in an identical way. The location of the piston bore may be changed to improve accessibility.

Accordingly it is the object of the invention to provide a hydraulically actuated toolholder design, that eliminates the disadvantages of contamination in the hydraulic circuit and therefore reduces seal wear and toolholder failure, is less expensive and simpler to manufacture, eliminates the need of a bleed hole, reduces the overall volume of the hydraulic circuit and virtually eliminates the presence of air in the hydraulic circuit.

These and other objects of the present invention will become apparent with reference to the drawings, the description of the preferred embodiment and the appended claims.

DESCRIPTION OF THE DRAWINGS

Figure 1. "Toolholder body & cartridge insert":

An isometric view of the toolholder body and the cartridge insert (not assembled).

Figure 2. "Assembled toolholder":

A cross-sectional view of the assembled toolholder with cartridge, piston seal, piston and actuation screw.

Figure 3. "Cartridge & hydraulic circuit design, concept 1":

An isometric view of a first design for the cartridge shell, cartridge body and the resulting hydraulic circuit, showing the clamping volumes and the flow connections between the clamping volumes and the piston bore.

Figure 4. "Cartridge & hydraulic circuit design, concept 2":

An isometric view of a second design for the cartridge shell, cartridge body and the resulting hydraulic circuit, showing the clamping volumes and the flow connections between the clamping volumes and the piston bore.

Figure 5. "Cartridge & installed piston seal":

A cross-sectional view of the cartridge with the piston seal installed.

Figure 6. "Cartridge & installed piston seal and piston":

A cross-sectional view of the cartridge with the piston seal and the piston installed.

Figure 7. "Mandrel-type holder with separate cartridge":

An isometric view of a mandrel-type holder with a separate cartridge containing the complete hydraulic circuit.

Figure 8. "Mandrel-type holder with integrated hydraulic circuit":

An isometric view of a mandrel-type holder with an integrated hydraulic circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

CLAIMS

ABSTRACT OF THE DISCLOSURE

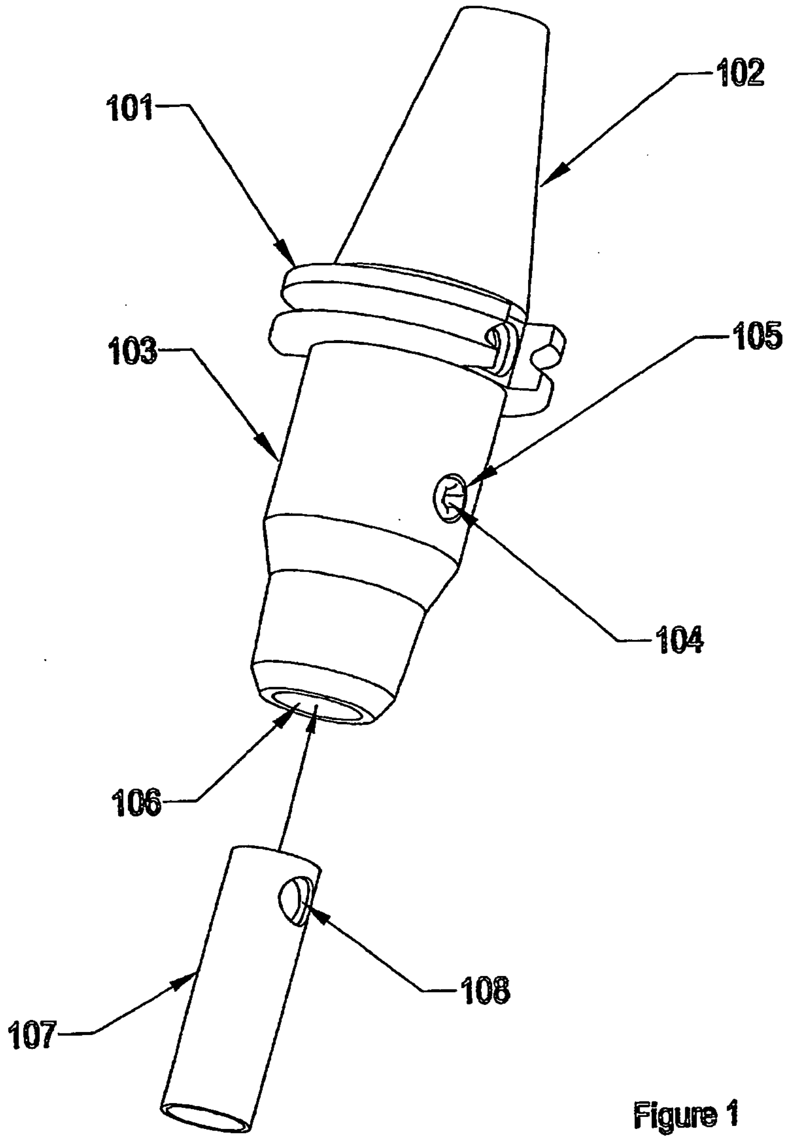
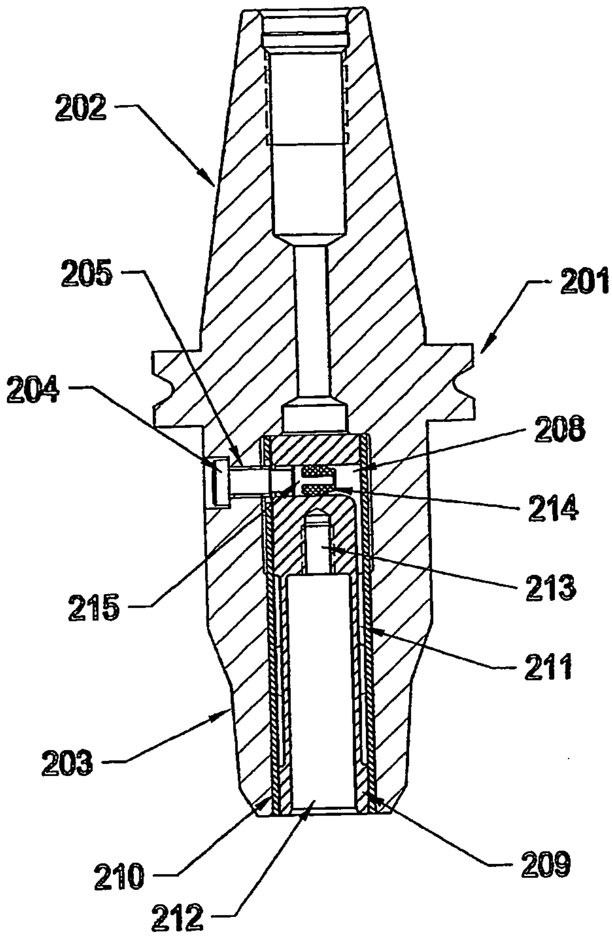


Figure 1



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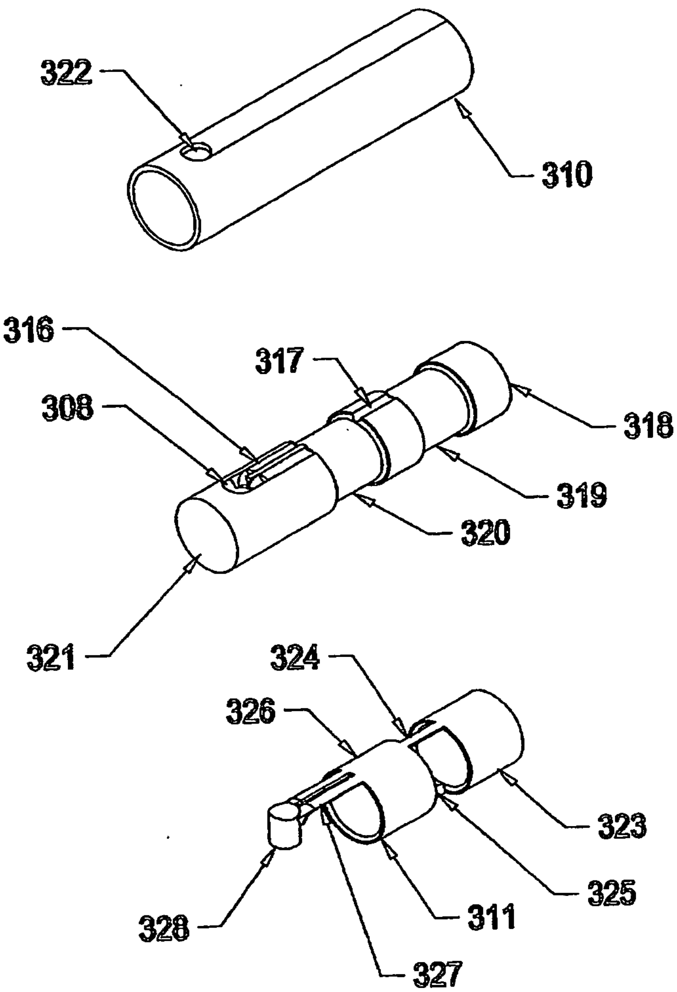

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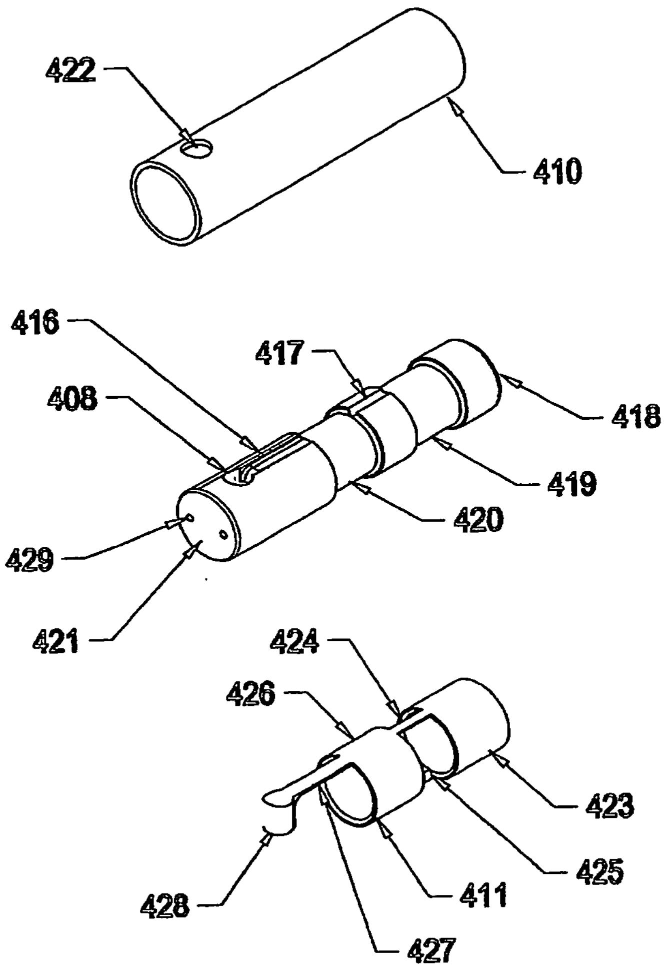
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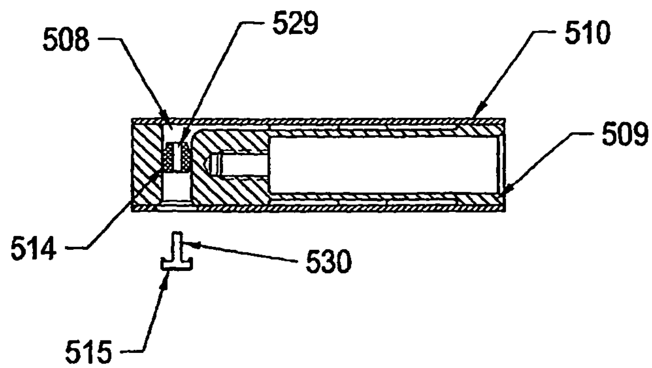
Figure 4



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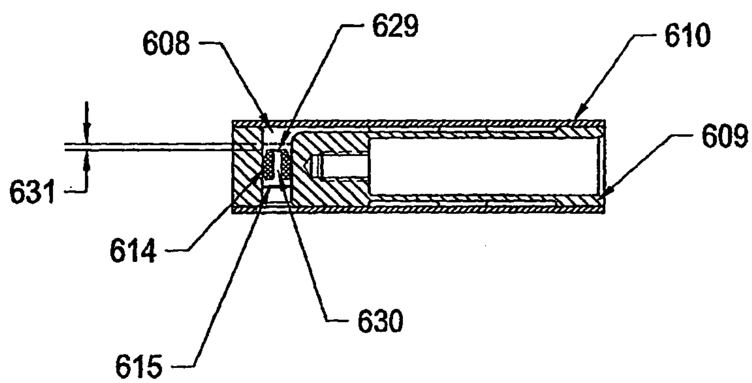

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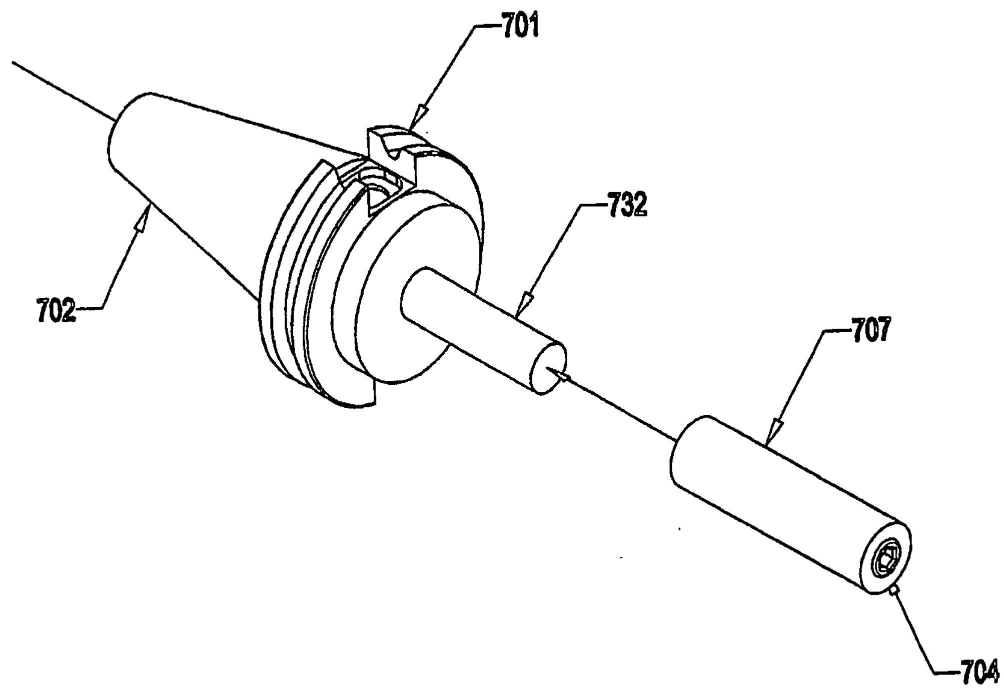

Figure 7

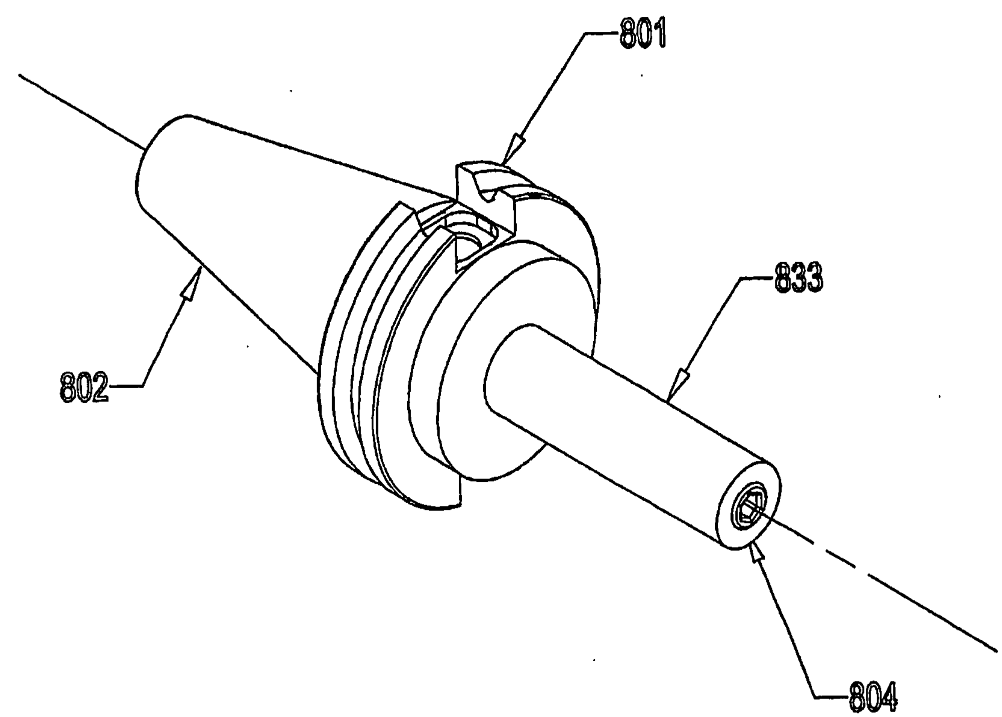

Figure 8